ISASE 2020

Emotional Map : Building a Data Tool for Geolocation-related Product Design

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Abstract: This article introduces a solution of design simulation system based on data processing. It is to observe and analyze user behavior by reflecting a large number of user behavior data trajectories on city maps. We believe that under the technical background of big data and cloud technology, it is possible to build a tool that can help designers to predict user behavior to a certain extent. This article describes the design of the simulation system divided into five stages: data collection, local database establishment, cloud database establishment, user model simulation, and user model-based behavior prediction. We also introduce the experimental design for the first stage: data collection. This research proposes an experimental method of using sensor-based wearable data collecting devices to simulate the scenario with users of smart wearable devices and using the method of diary studies to create user profiles. The study believes that user's emotion data, such as subjective feelings, which is difficult to measure directly through physical sensors, also plays an important role in the simulation analysis of the design process. This study collated the multi-dimensional information categories needed for user analysis of geolocation-based designs, including geographic data, biological data, and emotional data. In the experiment, a mechanism for collecting emotional data through user's subjective selection was also introduced.
Keywords: *Information processing, Data collection, Information design*

1. INTRODUCTION

In the popular environment of digital information products, wearable computing has become a hot topic. Supported by the increase in the holding rate of personal terminals with data collection capabilities, various big-data information processing systems have been established.

This study believes that under such technical and marketing background, the big-data analysis and processing system constructed by using the developing personal information terminals as nodes can become a powerful tool in the product design field [1].

Analysis and prediction of user behavior has always been a major issue for designers. In a usual product design process, designers can use methods such as observation, functional prototypes, and user testing to evaluate and analyze design solutions. By analogy to mechanical structure design or information system design, we believe that product designers will need a systematic tool that can build user models based on big data and simulate user behavior.

This research aims on proposing an information tool that can reflect user behavior trajectories, especially emotional change trajectories. The basic concept of this tool is an information processing tool based on geographic information system (GIS), which reflects user behavior data collected in the system in the form of information layers.

1.1 Product designer and information tool

The procession of product design varies greatly depending on the designer. But in different design processes, information acquisition and user research are important steps. In the fields of architectural design and bridge design, designers can use computer simulation tools to verify and derive design solutions [2]. On the basis of field research, user observation and other methods, product design lacks efficient user portrait simulation tools, and sometimes can only rely on design experience or more theoretical design methods to establish user portraits [3]. Among them, the product design related to geographical location depends more on the designer's observation and analysis of user behavior trajectory in a specific location.

Existing long-term recording methods such as user diaries are difficult to adapt to the cycle of product replacement or new design proposal [4]. The model testing method will cause higher costs. We believe that effective information tools can improve the productivity of product designers.

1.2 Wearable device and data collection

This is the era when wearables are highly popular. Relevant research has pointed out that there are more than 400 types of smart wearable devices in the current market, and as early as 2016, the global shipment of such devices exceeded 100 million [5].

With these devices, research on the collection of user physiological data using non-invasive wearable computers is also widely used [6]. The most typical examples are health applications that provide users with exercise suggestions based on stride and frequency [7], physical condition monitoring equipment in the medical field, and even Nintendo switch game consoles that create sports games with somatosensory equipment.

Some studies have pointed out that under the rapid development of sensor technology, the traditional impression that "physiological sensing is invasive" has been changed [5], and people have begun to accept these sensing devices into their lives. In this context, it becomes possible to use wearable devices to collect users' geographic location information, biometric information, and establish a big data environment.

1.3 Geographic Information System (GIS)

As the development of the concept of "map", since the 1970s, people have begun to attach importance to and use computer-based geospatial data systems, GIS [8]. And we can always contact the application of this system in life, such as weather maps, city sightseeing maps and navigation systems.

The basic idea of this system is to use the computer to store, manage, analyze, and display geospatial data [8]. The common application is to use different information layers for showing different information in the same geographic space.

This research is expected to comprehensively analyze the collected user location and behavior information through a computer, which can automatically generate an "user behavior and emotion" information layer in an existing urban GIS, and perform a dynamic display of changing conditions like a temperature map.

2. METHODOLOGY

This section will detail the structure of the information system proposed by the study. In addition, in order to facilitate the design of the information collection system, this study will classify the data to be collected by dimensions and collection methods. This article will introduce the design scheme of data collection experiment based on user diary method.

2.1 Structure of the system

As mentioned earlier, the system proposed by this research is a user-based information collection and processing system.

The personal information terminal held by each user will serve as a "node". Each "node" collects and consolidates user data and uploads this data to a database located on the server. In order to facilitate the processing and use of information, the database can be divided into "local databases" by blocks, schools or administrative divisions. Each local database can independently provide information layers for local map-based GIS applications.

Cloud databases can integrate and process huge user data in units of countries and even globally. Based on this amount of data, a simple user model can be built using machine-learning-related methods. Using the user model as a user portrait, combined with calculation methods for environmental simulation, a model for predicting user behavior can be established.

2.2 Categories of data

In order to efficiently collect and manage data, this study divides the data to be collected into three major categories: geodata, biodata, and emotional data. Among them, geodata refers to the geographical information (including the existing urban zoning and building information in GIS), time information, and the movement path of each node. Biodata includes stride and cadence information used to detect the user's motion status, user limb movement information that can be obtained using a posture sensor, and heart rate. Emotional data mainly refers to users' subjective feelings and self-emotional cognition, which are difficult to measure directly through physical sensors.

Figure 1: Structure of the system

Table 1: Categories of data

Categories	Required data	Recording method
Geodata	Existing city map	GIS
	Current location	GPS module
	Time	Timer module
	Path of device movement	GPS module
Biodata	Stride	Gyroscope + GPS
	Gait frequency	Gyroscope + GPS
	Limb movement	Gyroscope
	Heartbeat	Heartbeat sensor
Emotion	Subjective feelings	Indirect measure

These data can be captured by different sensors mounted on personal information terminals. In the early experiments of this research, emotional data will be mainly used as a comparative information item and measured by indirect methods.

2.3 Experimental device design

The aim of the first phase of this research is to design a data collection and processing plan on the user node side.

The definition of user nodes has been described above. In order to facilitate the establishment of an experimental environment, the experimental device is designed as a smart watch-type terminal connected to a smartphone with a Bluetooth function.

The design idea is to put the server communication and data storage functions on the smart phone side, which can greatly save the internal space of the wearable equipment and reduce the device volume. In fact, this experimental device is a simulation of the smart wearable device environment. Therefore, in addition to the function of the collection of emotional data, it should be able to be reproduced with market commodity equipment.

The function implementation and component requirements of the experimental device correspond to the following:

The device is controlled by a microcomputer Beetle.

Communication with smart phones is achieved through Bluetooth modules.

The gyroscope module is used to detect the posture of the device. Then computer can record the movement trajectory of the wearer's limb [9].

The GPS module or GPS-equipped smart phone can record the spatial position and movement path of the node.

The wearer's emotion data is collected through the key module, and the subjective feelings of the wearer at a specific time point are recorded.

The experimental device also includes a battery and the necessary IO connections. In the experiment, it will be used in conjunction with a smartphone in the Android environment set up and provided by the researcher.

2.4 Research tools

The main research method used in this study during the data recording phase is based on the diary study method [4]. The diary study is mainly used to study user behavior in human-computer interaction. It is a research method that combines the advantages of laboratory environment and field environment. In the diary study method, the researcher distributes log forms to the participants of the experiment and records all the participants' activities through a long-term log form.

In this study, the experimental device that automatically records participants' trajectories, biological data, and geographic data will output data in the form of a log, allowing participants to complete this experiment in a daily workspace rather than a laboratory environment.

In order to record the participants 'emotional data, the experimental device requires the participants to press one of the three buttons from time to time to describe the participants' subjective emotional feelings at this moment. The three buttons represent: Excited, Anger (Energetic) / Tender, Happy / Sad, Scared (non-Energetic) [10] [11].

As with the manual diary study, another part of the data collection comes from interviews after the experiment. The data from this interview will be used to verify the accuracy of the log (e.g. have you been to a place at a certain moment?).

2.5 Procedure

The system structure design involved in this research has been introduced in the previous article. The specific methods of system communication and data collection experiments will be discussed in subsequent studies.

For the experimental device, after the completion of the pilot test, a small-scale long-term log record will be performed to verify the reliability of the device scheme. For data processing, tests of data summary and information layer drawing will be performed at the same time as the experimental device test.

The highlights of each phase of this study are as follows:

1. Design and improvement of experimental equipment.
2. Experimental device human-computer interaction performance verification and field environment test.
3. Small-scale data measurement experiments.

4. Regional data measurement experiments and regional database tests.
5. Database communication test and subsequent technology research.

3. EXPECTED RESULTS

This study is expected to simulate real wearable device data collection environments through device experiments. On this basis, a set of information layer rendering system is established based on the collected data. This system provides a reference of user behavior information based on geographic location in the product design process by projecting the information layer into an existing GIS.

For the initial experimental device design and verification process, it is expected that the feasibility of the device will be verified by long-term log recording. In addition, the impact of different communication conditions and interference conditions in the real environment must also be evaluated.

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